C3

a second order difference value acquisition step of acquiring second order differences values from one-dimensional image data of the object area;

Please rewrite the paragraph from page 6, line 11 through page 6, line 14, as follows:

C4

an irradiation end extraction step of extracting a coordinate of an end point of the irradiation area from the second order difference values acquired in the second order difference value acquisition step;

Please rewrite the paragraph from page 9, line 20 through page 10, line 14, as follows:

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Fig. 2 is a block diagram to show the inside structure of the irradiation area extraction unit 102, in which reference numeral 200 designates a calculation area input unit for accepting input of a direction, a start point, and an end point for determination of calculation areas and 201 a calculation area determination unit for determining, based on the input information at the calculation area input unit 200, areas of calculation carried out by a calculation unit 202 from the input image supplied from the image input unit 101. Numeral 202 denotes a calculation unit for calculating primary difference values and a second order difference value, described hereinafter, from the calculation areas determined at the calculation area determination unit 201, 204 a judgment unit for judging irradiation area ends, 203 a memory unit for storing the values calculated at the calculation unit 202 and the irradiation area ends judged at the judgment unit 204, and 205 an irradiation area determination unit for determining the irradiation area from the irradiation area ends stored in the memory unit 203 and judged at the judgment unit 204.

Please rewrite the paragraph from page 10, line 15 through page 10, line 26, as follows:

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Fig. 3 is a flow chart to show the flow of the processing at the irradiation area extraction unit 102. Fig. 4 is a diagram to show the calculation areas determined at the calculation area determination unit 201. Fig. 5A is a diagram to show a radiographic image and Fig. 5B is a diagram to show density values on line X_0 to X_3 of Fig. 5A. The abscissa indicates positions on the line X_0 to X_3 and the ordinate density values on the line. Fig. 6A is an enlarged view of part of Fig. 5B. Fig. 6B is a plot of second order difference values calculated at the calculation unit 202 against points on the above line between X_0 and X_3.

Please rewrite the paragraph from page 11, line 12 through page 12, line 12, as follows:

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The processing at the irradiation area extraction unit 102 of Fig. 2 will be described next according to the flow of Fig. 3. The irradiation area extraction unit 102 receives the input of the calculation direction, the calculation start point, and the calculation end point necessary for the determination of the calculation areas at the calculation area input unit 200 (step S301). It is, however, noted that the input herein is required only for an initial input screen and it does not have to be set for the next input screen and after. Next, the calculation area determination unit 201 determines the calculation areas, based on the information from the calculation area input unit 200. The calculation areas herein are three areas A, B, and C of a rectangular shape arranged in parallel on the image, as illustrated in Fig. 4, and are used as calculation areas for calculation of the second order difference value at a calculation point indicated by (x,y). These three areas A, B, and C have an equal area which is determined by two parameters of "a" and "b" and the distance between the areas is represented by "d". These parameters "a", "b", "d" are determined experimentally. The calculation area determination unit 201 preliminarily determines the calculation areas for all calculation points and the result, together with information of duplicate calculation areas, is stored in the memory unit 203 (step S302).

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Please rewrite the paragraph from page 12, line 13 through page 13, line 6, as follows:

Then the calculation unit 202 calculates representatives of density values in the above calculation areas A, B, and C according to a method described hereinafter and further calculates the primary difference values and the second order difference value. The primary difference values are two values, which are a value "e" resulting from subtraction of the density representative in the area B from the density representative in the area C and a value "f" resulting from subtraction of the density representative in the area A from the density representative in the area B. The second order difference value is a value resulting from subtraction of the value "f" from the value "e". The primary difference values and second order difference value calculated in this way are stored in the memory unit 203. From the duplicate information of the calculation areas stored in the memory unit 203, the primary difference values for duplicate calculation areas are obtained from the values stored in the memory unit 203 and the second order difference value thereof is calculated using them (steps S303 and S304).

Please rewrite the paragraph from page 13, line 7 through page 13, line 26, as follows:

Then the judgment unit 204 judges the irradiation area ends from the primary difference values and the second order difference values stored in the memory unit 203. Fig. 6B shows the second order difference values calculated at the calculation unit 202. The second order difference values are negatively large at the points X_1 and X_2 where the densities vary suddenly, and the aforementioned primary difference values f take positive values in a density increasing direction (when seen from the side of the point X_0) but take negative values in a density decreasing direction. From this property the judgment unit 204 judges that a point where the above second order difference value is minimum and the primary difference values are positive is a candidate for an end point of the irradiation area. If there are plural candidates, the judgment unit determines that a first appearing

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candidate is an end point of the irradiation area (step S305). Then the irradiation area end point is stored in the memory unit 203 (step S306).

Please rewrite the paragraph from page 13, line 27 through page 14, line 13, as follows:

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Further, the judgment unit 204 judges whether the processing is completed for all the directions supplied from the calculation area input unit 200 and, if not, the processing is repeated from step S302 (step S307). After the irradiation area end points are determined in all the directions, the irradiation area determination unit 205 determines the irradiation area. Here, a line passing the end point of the irradiation area and being perpendicular to the calculation direction of the second order difference value (for example, the direction from X_0 to X_3 in Figs. 5A and 5B) is calculated for all the end points of the irradiation area and an area surrounded by these lines obtained is determined as an irradiation area (step S308).

Please rewrite the paragraph from page 14, line 14 through page 14, line 20, as follows:

C11

The present embodiment presents the effects of less computational complexity and capability of readily extracting the end point of the irradiation area, because the calculation unit 202 is arranged to calculate the representatives of density values in the calculation areas A, B, C and calculate the second order difference value based on the representative values.

Please rewrite the paragraph from page 16, line 17 through page 16, line 20, as follows:

C12

In the present embodiment, where the representative value of each area A, B, or C is S(A), S(B), or S(C), respectively, the second order difference value SS(X) is calculated according to Eq. (1) below.

Please rewrite the paragraph from page 17, line 23 through page 18, line 3, as follows:

C13

In other words, the above approach is nothing but an operation in which projection of pixel values is made with respect to a predetermined direction (the vertical direction) of the area, values obtained by the projection are smoothed using a one-dimensional morphology filter, and the second order difference value is calculated with the distance d.

Please rewrite the paragraph from page 18, line 21 through page 19, line 6, as follows:

C14

Since the device according to the present embodiment is arranged to determine the calculation areas comprised of the plural areas of the predetermined shape arranged in the predetermined direction, calculate the second order difference value of the density values representing the respective areas in the plural areas, and judge one end point of the irradiation area from the second order difference value thus calculated, the present embodiment presents the effects of capability of decreasing the computational complexity and in turn decreasing the computation time and capability of extracting the end points of the irradiation area with accuracy.

Please rewrite the paragraph from page 20, line 4 through page 20, line 23, as follows:

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The judgment unit 2110 is composed of a second order difference value calculation circuit 2201 for calculating the second order difference value from data of an object area in an input image, a left end point extraction circuit 2202 for extracting a left end point of an irradiation area included in the object area, based on the second order difference value calculated at the second order difference value calculation circuit 2201, a right end point extraction circuit 2203 for extracting a right end point of the irradiation

area included in the object area, based on the second order difference value calculated at the second order difference value calculation circuit 2201, and a diaphragm presence/absence judgment circuit 2204 for judging whether the object area is an area with an irradiation diaphragm or an area without an irradiation diaphragm, from the left end point extracted at the left end point extraction circuit 2202 and the right end point extracted at the right end point extraction circuit 2203.

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Please rewrite the paragraph from page 21, line 25 through page 22, line 2, as follows:

First, when the area C is an object area, the second order difference value calculation circuit 2201 calculates the second order difference values SS(x) data of the area C according to Eq. (21) below (step S2301).

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Please rewrite the paragraph from page 22, line 9 through page 22, line 14, as follows:

Next, using the second order difference values SS(x) calculated at the second order difference value calculation circuit 2201, the left end point extraction circuit 2202 extracts the left end point x1 of the irradiation area included in the area C according to Eq. (22) below (step S2302).

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Please rewrite the paragraph from page 22, line 19 through page 22, line 24, as follows:

On the other hand, using the second order difference values SS(x) calculated at the second order difference value calculation circuit 2201, the right end point extraction circuit 2203 extracts the right end point x2 of the irradiation area included in the area C according to Eq. (23) below (step S2303).

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Please rewrite the paragraph from page 24, line 6 through page 24, line 13, as follows:

c19 As described above, the present embodiment is arranged to calculate the second order difference values SS(x) from the data of the object area subjected to the judgment of presence/absence of the radiation diaphragm in the two-dimensional input image G and judge whether the object area is an area with or without the irradiation diaphragm, using the second order difference values SS(x).

Please rewrite the paragraph from page 24, line 27 through page 25, line 8, as follows:

c20 It may also be contemplated that on the occasion of extracting the left end point xl and the right end point x2 in the object area at the left end point extraction circuit 2202 and at the right end point extraction circuit 2203, another condition for the second order difference values SS(x) used in the extraction, for example such a condition that the second order difference values SS(x) are not more than a fixed threshold, is added.

Please rewrite the paragraph from page 26, line 19 through page 27, line 9, as follows:

c21 The judgment unit 2140 is composed of, as illustrated in Fig. 10, a coordinate indication circuit 2404, a second order difference value calculation circuit 2401 for calculating the second order difference values from data of an object area (either one of the areas A to D in the input image G of Fig. 8 in this example) in the input image according to coordinates indicated by the coordinate indication circuit 2404, a left end point extraction circuit 2402 for extracting a left end point of the irradiation area included in the object area, based on the second order difference values calculated at the second order difference value calculation circuit 2401, and a right end point extraction circuit 2403 for extracting a right end point of the irradiation area included in the object area,

C21 based on the second order difference values calculated at the second order difference value calculation circuit 2401.

Please rewrite the paragraph from page 28, line 6 through page 28, line 12, as follows:

C22 The coordinate indication circuit 2404 is configured to give an indication of a coordinate for calculation of the second order difference value at the second order difference value calculation circuit 2401 thereto after the left end point extraction circuit 2402 and the right end point extraction circuit 2403 extract the left and right end points.

Please rewrite the paragraph from page 28, line 20 through page 28, line 25, as follows:

C23 First, supposing the area C is an object area, the second order difference value calculation circuit 2401 calculates the second order difference values SSi(x) from the data of the area C according to Eq. (25) below for each coordinate i indicated by the coordinate indication circuit 2404 (step S2501).

Please rewrite the paragraph from page 29, line 8 through page 29, line 12, as follows:

C24 Using the second order difference values SSi(x) calculated at the second order difference value calculation circuit 2401, the left end point extraction circuit 2402 then extracts the left end point xLi according to Eq. (26) below (step S2502).

Please rewrite the paragraph from page 29, line 21 through page 29, line 25, as follows:

C25 Using the second order difference values SSi(x) calculated at the second order difference value calculation circuit 2401, the right end point extraction circuit 2403 also extracts the right end point xRi according to Eq. (27) below (step S2504).

Please rewrite the paragraph from page 30, line 6 through page 30, line 11, as follows:

C26 After completion of the storage of the left end point xLi and the right end point xRi in the memory circuit 2405, the coordinate indication circuit 2404 gives another instruction of a coordinate i of a new horizontal line to the second order difference value calculation circuit 2401 (step S2506).

Please rewrite the paragraph from page 30, line 12 through page 30, line 16, as follows:

C27 According to this indication, the processing from step S2501 is carried out again. This loop processing is executed before the coordinate indication circuit 2404 gives an indication of the end to the second order difference value calculation circuit 2401.

Please rewrite the paragraph from page 30, line 17 through page 30, line 25, as follows:

C28 After steps S2501 to S2506 are carried out repeatedly and the processing is terminated according to the end indication from the coordinate indication circuit 2404, the memory circuit 2405 is in a storage state of the left end points xLi and the right end points xRi corresponding to the coordinates i indicated during the processing by the coordinate indication circuit 2404 to the second order difference value calculation circuit 2401.

Please rewrite the paragraph from page 33, line 3 through page 33, line 10, as follows:

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C29 As described above, the present embodiment is arranged to carry out the detection of the irradiation ends on the plural lines in the object area while the coordinate indication circuit 2404 gives the indications of the coordinates i of one-dimensional data lines crossing the object area in the horizontal direction to the second order difference value calculation circuit 2401.

Please rewrite the paragraph from page 34, line 4 through page 34, line 11, as follows:

C30 The present embodiment is arranged to calculate the second order difference values SS(x) according to above Eq. (21) and to extract the left end point xl of the irradiation area included in the object area, using the second order difference values SS(x), for example, similar to Embodiment 2-1 described above. At this time the present embodiment also uses the sign of the primary difference value S(xl) given by Eq. (28) below.

Please rewrite the paragraph from page 35, line 16 through page 35, line 22, as follows:

C31 The present embodiment is arranged first to calculate the second order difference values from the data of the object area, for example similar to Embodiment 2-1, but at this time, the present embodiment is arranged to calculate the second order difference values from data obtained after the data of the object area is filtered.

Please rewrite the paragraph from page 35, line 23 through page 36, line 1, as follows:

C32 Specifically, for example, the image data of a one-dimensional line of an object area is represented by "f(x)", the data is subjected to a filtering process according to Eqs. (30) and (31) below, and the second order difference values are calculated from the

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values F2 obtained as a result.

Please rewrite the paragraph from page 38, line 23 through page 39, line 2, as follows:

C33

According to each coordinate i indicated by the coordinate indication circuit 3201, the characteristic value extraction circuit 3202 then calculates a characteristic value of one-dimensional image data corresponding to the coordinate i, for example, the second order difference values Ssi(y) according to Eq. (41) below (step S3302).

Please rewrite the paragraph from page 39, line 9 through page 39, line 15, as follows:

C34

Using the second order difference values SSi(y) obtained at the characteristic value extraction circuit 3202, the end point extraction circuit 3203 then extracts a coordinate yi of an end point (an irradiation end point) of the irradiation area included in the object area according to Eq. (42) below (step S3303).

Please rewrite the paragraph from page 41, line 10 through page 41, line 24, as follows:

C35

Since the device is constructed to use the second order difference value in order to extract the irradiation end, boundary points can be extracted with accuracy between an area irradiated directly and the other areas even in a photographic image obtained by photographing a subject with low transmittances of radiation. Therefore, the device of the present embodiment can judge the presence/absence of the irradiation diaphragm in the object area including the irradiation diaphragm in the object area including the irradiation area with accuracy. In addition, the presence/absence of the irradiation diaphragm in the object area can be judged with accuracy even in a photographic image in which a portion with low radiation transmittances such as the abdominal part or the like overlaps with an end portion of the image.

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Please rewrite the paragraph from page 41, line 25 through page 42, line 10, as follows:

Although the present embodiment is arranged to use the second order difference value in order to make a judgment of the irradiation diaphragm, the apparatus of the present invention does not always have to be limited to this; for example, where change C36 of density is quick at an irradiation end, the apparatus may also be arranged to use the primary difference values or higher-order difference values. In this case, the primary difference values or the higher-order difference values are obtained from the object area and a first appearing point of a value not less than a predetermined threshold is regarded as a candidate for an irradiation end.

Please rewrite the paragraph from page 43, line 16 through page 43, line 23, as follows:

The present embodiment is arranged to calculate the second order difference values SSi(y) according to above Eq. (41) and extract the irradiation end of the object C37 area using the second order difference values SSi(y), for example, as Embodiment 3-1 described above was. At this time, the present embodiment also uses the sign of the primary difference value Si(y) expressed by Eq. (44) below.

Please rewrite the paragraph from page 44, line 18 through page 44, line 24, as follows:

The present embodiment is arranged first to calculate the second order difference values from the data of the object area, similar to Embodiment 3-1; but at this time, the C38 data of the object area is subjected to a filtering process and the second order difference values are calculated from the data after the filtering process.

Please rewrite the paragraph from page 44, line 25 through page 45, line 3, as follows:

C39 Specifically, for example, where the image data of a one-dimensional line of the object area is "f(x)", it is subjected to the filtering process according to Eq. (45) and Eq. (46) below and the second order difference values are calculated from values F2 obtained as a result.

Please rewrite the paragraph from page 45, line 9 through page 45, line 16, as follows:

C40 When Embodiment 3-1 is modified so as to calculate the second order difference values after the data of the object area is smoothed by the filtering process as described above, whether the irradiation diaphragm is present or absent in the object area can be judged with better accuracy without being affected by the noise, particularly, without being affected by the noise on the line.

Please rewrite the paragraph from page 47, line 18 through page 47, line 24, as follows:

C41 The characteristic quantity calculation means 4101 of Fig. 15 calculates the second order difference values according to Eq. (51) below (steps S4101 and S4102). In the equation fi(x) represents image data of the i-th row line indicated by the coordinate indication means 4103, Ssi(x) the second order difference values, and "c" a constant.

Please rewrite the paragraph from page 51, line 16 through page 51, line 22, as follows:

C42 In the present embodiment, where the image data of a one-dimensional line is f(x) and the second order difference values thereof are SS(x) defined by Eq. (1), the sign of

C42 the primary difference value S(XL) of Eq. (60) below is also added to the operation of extracting the end point XL at the end point extraction means 4102 (Fig. 15).

Please rewrite the paragraph from page 52, line 10 through page 52, line 17, as follows:

In the present embodiment, where the one-dimensional data of the i-th row is fi(x) and is subjected to the filtering process according to Eqs (64) and (65) below and values C43 resulting from the filtering process are defined as Fli(x) and F2i(x), characteristic quantity calculation means 4101 (Fig 15) uses F2i(x) for calculating the second order difference values defined by Eq. (51).

Please rewrite the paragraph from page 52, line 26 through page 52, line 27, as follows:

C44 Hence, the second order difference values are calculated as follows.

Please rewrite the paragraph from page 53, line 3 through page 53, line 8, as follows:

As described above, the present embodiment is arranged to smooth the one-C45 dimensional image data for calculation of the second order difference values by the filtering process, thereby accomplishing the effect of being not affected by the noise, particularly by the noise on the line.

Please rewrite the paragraph from page 55, line 18 through page 56, line 9, as follows:

Fig. 19 is a block diagram to show the structure of an area extraction device C46 according to the present embodiment. In Fig. 19, reference numeral 4301 designates a second order difference value calculation means for calculating the second order

difference values of one-dimensional image data in a designated direction (for example, which is determined according to the value determined by the angle extraction device described above), 4302 a left end point extraction means for extracting a left end point of the area, based on the second order difference values calculated at the second order difference value calculation means 4301, and 4303 a right end point extraction means for extracting a right end point of the area, based on the second order difference values calculated at the second order difference value calculation means 4301. Fig. 20 is a flow chart of a processing procedure sequence in the area extraction device according to the present embodiment.

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Please rewrite the paragraph from page 56, line 10 through page 56, line 19, as follows:

The flow of the processing in the present embodiment will be described according to Fig. 20. The second order difference value calculation means 4301 (Fig. 19) calculates the second order difference values SS(x) according to a calculation equation defined by Eq. (71) below (step S4301). Here, f(x) represents the one-dimensional data of a line crossing the area in the designated direction and x represents coordinates thereof. Further, "d" denotes a constant indicating a difference distance.

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Please rewrite the paragraph from page 57, line 7 through page 57, line 10, as follows:

As described above, since the present embodiment uses the second order difference values, it has the effect of capability of extracting the area with accuracy even if the density change is gentle at the area end.

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Please rewrite the paragraph from page 58, line 3 through page 58, line 24, as follows:

Fig. 21 is a block diagram to show the structure of an area extraction device according to the present embodiment. In Fig. 21, reference numeral 4401 designates a second order difference value calculation means for calculating the second order difference values of one-dimensional image data in a designated direction (for example, which is determined according to the value determined by the angle extraction device described above) indicated by a coordinate indication means 4404, 4402 a left end point extraction means for extracting a left end point of the area, based on the second order difference values calculated at the second order difference value calculation means 4401, a right end point extraction means for extracting a right end point of the area, based on the second order difference values calculated at the second order difference value calculation means 4401, and 4404 the coordinate indication means for indicating a coordinate of one-dimensional data for calculation of the second order difference values at the second order difference value calculation means 4401 after extraction of the right area end at the right end point extraction means 4403.

Please rewrite the paragraph from page 59, line 10 through page 59, line 19, as follows:

The second order difference value calculation means 4401 (Fig. 21) calculates the second order difference values SSi(x) according to a calculation equation defined by Eq. (75) below (step S4401). Here, fi(x) represents one-dimensional data of a line crossing the area in the designated direction, x coordinates thereof, and "i" a coordinate of the row in the designated direction indicated by the coordinate indication means 4404. Here, "d" represents a constant indicating a difference distance.

Please rewrite the paragraph from page 61, line 1 through page 61, line 5, as follows:

As described above, since the present embodiment uses the second order difference values, the boundary points of the area can be extracted with accuracy even if the density values vary gently at the boundary of the area.

Please rewrite the paragraph from page 61, line 12 through page 61, line 19, as follows:

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In the present embodiment, where the image data of a one-dimensional line in the designated direction is expressed by f(x) and the second order difference values thereof by SS(x) defined by Eq. (78) below, the sign of the primary difference value S(XL) defined by Eq. (79) below is added to the extraction of the left end point XL at the left end point extraction means 4302 (Fig. 19) or 4402 (Fig. 21).

Please rewrite the paragraph from page 62, line 17 through page 62, line 24, as follows:

C53

In the present embodiment, where the one-dimensional data in the designated direction is defined by f(x) and values resulting from the filtering process according to Eqs. (83), (84) below are defined by Fl(x), F2(x), the values F2(x) are used for calculation of the second order difference values at the second order difference value calculation means 4301 (Fig. 19) or 4401 (Fig. 21).

Please rewrite the paragraph from page 63, line 6 through page 63, line 11, as follows:

C54

As described above, since the present embodiment is arranged to smooth the one-dimensional image data for the computation of the second order difference values by the filtering process, it has the effect of being not affected by the noise, particularly, by the noise on the line.